

**REMARKS**

Claim 1 has been amended to incorporate therein the recitation of claim 6, 7, 11, 18 (in part) and 20. Claims 6-11, 19, 20 and 22 have been canceled. Claims 12, 13, 14, 15, 16, 17 and 18 have been amended to depend from and conform to the amendment to claim 1. Additionally, “tetrahydrofuran, tetrahydropyran, furan, furfural,  $\gamma$ -butyrolactone and dioxane” have been deleted from the Markush group of claim 15 defining the ether compound.

Claims 13 and 14 have also been amended to refer to the molecular structure of the organic solvent. This amendment does not narrow the scope of original claims 13 and 14.

Additionally, Applicants present new claim 23 for examination.

Method claim 23 includes all of the limitations of product claim 1. Therefore, if claim 1 as amended herein is found to be patentable, then so is claim 23 directed to a method for using the etching solution of claim 1.

Entry of the amendments and review and reconsideration on the merits are requested.

Claim 15 was rejected under 35 U.S.C. § 112, second paragraph. The Examiner considered claim 15 to be indefinite because it includes  $\gamma$ -butyrolactone as an ether, whereas the subject compound is conventionally known as a lactone.

The amendment to claim 15 renders the rejection moot. Withdrawal is respectfully requested.

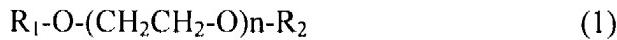
***Response to Rejection of Claims 1-13, 15 and 19-20 over Jagannathan et al.***

Claims 1-13, 15 and 19-20 were rejected under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 6,200,891 to Jagannathan et al. Jagannathan et al. was cited as disclosing an etching solution comprising HF and an organic solvent, such as diglyme, within the scope of the rejected claims. Because

Jagannathan et al. is said to disclose an etching composition having the same composition or one overlapping in scope with the claimed invention, the Examiner considered that the etching solution of Jagannathan et al. would *inherently* exhibit an etching rate ratio of a THOX film to that of a High-k film of 50 or less as required by present claim 1.

Applicants traverse, and respectfully request the Examiner to reconsider in view of the amendment to the claims and the following remarks.

The present invention relates to an etching solution comprising hydrogen fluoride and a specific ether compound in specific proportions. Specifically, the etching solution comprises 3 mass% or more of a fluorine compound and 50 to 97 mass% of an ether compound, etc., represented by the following formula (1):



In addition to propylene glycol monomethyl ether, propylene glycol monopropyl ether, and propylene glycol monobutyl ether.

Since the etching solution of the present invention has the above-described feature, High-k films, such as hafnium silicate, hafnium aluminate, etc., can be etched, and the etch rates of oxide films, such as THOX, TEOS, and the like can be reduced. Specifically, the etching rates of High-K films with a relative dielectric constant of 8 or more can be adjusted to 2 Å/minute or more. Also, the ratio of the etch rate of a thermal oxide film to that of a High-k film can be adjusted to 50 or less.

Turning to the cited prior art, Jagannathan et al does not disclose the etching solution of amended claim 1. Specifically, Jagannathan et al does not disclose the etching solution comprising 50 to 97 mass% of a specific ether compound as set forth in claim 1. For this reason alone, it is respectfully submitted that the amended claims are patentable over Jagannathan et al.

Jagannathan et al. exemplifies an etching solution containing 31 parts by volume of a 49 % by weight aqueous solution of HF with about 20 parts by volume of propylene carbonate (a cyclic ether) and about 10 parts by volume of acetic anhydride (Example 1 at column 5, lines 30-45). There is no further disclosure in Jagannathan et al. with respect to the content of the organic solvent in the etching solution.

In this regard, claim 1 has been amended to incorporate therein the recitation of claim 20, to recite a content of the ether compound of 50 to 97 mass%, to thereby distinguish over Jagannathan et al which does not disclose the content of the organic solvent in the etching solution other than by reference to Example 1. In Example 1, the organic solvent is present in an amount of  $20/(31+20+10) = 33$  wt% well outside the scope of amended claim 1. Moreover, the organic solvent used in Example 1 of Jagannathan et al is propylene carbonate, and is not an ether compound within the scope of amended claim 1.

With regard to the effects of the invention, Jagannathan et al does not suggest that High-K films, such as hafnium silicate, can be effectively etched, while the etch rate of silicon dioxide film is reduced. Therefore, even a person skilled in the art could not predict the effects of the invention based on the description of Jagannathan et al.

Moreover, there is no apparent reason which would lead one of ordinary skill in the art to modify the etching solution of Jagannathan et al to increase the content of the organic solvent (ether compound) to within an amount of at least 50 mass% as claimed, or to employ the specific ether compound as set forth in amended claim 1.

For the above reasons, it is respectfully submitted that the amended claims are neither anticipated nor obvious over Jagannathan et al, and withdrawal of the foregoing rejection is respectfully requested.

***Response to Rejection of Claims 14 and 16 over Jagannathan et al. in view of Zuel et al.***

Claims 14 and 16 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Jagannathan et al. in view of U.S. Patent No. 5,120,605 to Zuel et al. Zuel et al. was cited as teaching an etching solution for oxide surfaces containing HF and ether, diethylene glycol diethyl ether and diethylene glycol monomethyl ether. The reason for rejection was that "it would have been obvious...to have hydrofluoric acid and diethylene glycol monomethyl ether as etching solution, because it is suitable for etching oxides."

Applicants respectfully traverse for the following reasons.

Zuel et al does not disclose an etching solution comprising hydrogen fluoride and 50 to 97% mass% of the specific ether compound set forth in amended claim 1.

Zuel et al refers to ether and the like as a water soluble moderator (col. 4, lines 38 to 42). However, Zuel et al nowhere discloses that ether and the like are contained in a proportion of 50 to 97% by weight.

In Table 1 (col. 5) of the Examples, only sorbitol is disclosed as a water soluble moderator, and the ether compound of the present invention is not used.

Moreover, as a matter of course, Zuel et al does not suggest that High-k films can be effectively etched by mixing specific amounts of fluorine and an ether compound.

For the above reasons, it is respectfully submitted that claims 14 and 16 are patentable over Jagannathan et al in view of Zuel et al, and withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

***Response to Rejection of Claim 17 over Jagannathan et al. and Dodge***

Claim 17 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Jagannathan et al. and U.S. Patent No. 4,469,525 to Dodge. Dodge was cited as disclosing an etching solution

*for etching oxides such as concrete,* comprising a strong mineral acid such as HF and a solvent such as cellosolve acetate.

Applicants respectfully traverse for the following reasons.

Dodge nowhere discloses an etching solution comprising fluoride and further comprising an organic solvent in a proportion of 50 mass% or more.

For example, in reference to Table 1 of Dodge, an etching solution comprising hydrogen fluoride and further comprising an organic solvent in a proportion of 50 mass% or more is not disclosed. Table 1 merely shows a solution in which the content of the organic solvent is much less than 50%. For example, in Table I of Dodge, the etching solution may contain up to 17 parts cellosolve acetate (i.e., well below 50 wt%).

Moreover, Dodge does not disclose that High-k films can be etched and/or that the etch rate of a silicon dioxide film is reduced.

Withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

***Response to Rejection of Claim 18 over Jagannathan et al. and Klein et al.***

Claim 18 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Jagannathan et al. and U.S. Patent Application Publication No. US 2003/0160026 to Klein et al. Klein et al. was cited as teaching an etching medium comprising ethylene glycol monobutyl ether and HF for etching oxide surfaces.

Applicants respond as follows.

Klein et al does not disclose an etching solution comprising fluoride and 50 mass% or more of an ether compound set forth in the amended claim 1.

Example 1 at paragraph [0112] describes preparation of an etching paste containing 21 g ethylene glycol monobutyl ether per 100 g of paste. Thus, the content of the ethylene glycol

monobutyl ether falls well below an amount of at least 50 weight % as required by amended claim 1.

Moreover, Klein et al. relates to an etching paste as opposed to an etching "solution" as required by the present claims.

Furthermore, Klein does not suggest suppressing the etching of a silicon dioxide film while selectively etching High-k films with a relative dielectric constant of 8 or more.

Withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

***Response to rejection of Claims 21 and 22 over Jagannathan et al. and Christenson et al.***

Claims 21 and 22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Jagannathan et al. and U.S. Patent Application Publication No. US 2003/0235985 to Christenson et al. Christenson et al. was cited as disclosing a process for etching high dielectric constant films more rapidly than coexisting SiO<sub>2</sub>, polysilicon, etc., films using an etching solution containing HF.

Applicants respond as follows.

Christenson et al does not disclose an etching solution comprising 3 mass% or more of HF and 50 to 97 mass% of an ether compound.

Christenson et al merely discloses an etching solution in which the content of hydrogen fluoride is less than 0.2 mass% ([0015], claim 1). Also, Christenson et al does not disclose an etching solution comprising the specific ether compound as set forth in claim 1 in a proportion of 50% or more.

Moreover, in Christenson et al, water is used as an essential solvent, and a large amount of fluorides are diluted with the water (see [0029]).

The contents of water, fluoride, and organic solvent are also completely different from those of the present invention.

Withdrawal of the foregoing rejection is respectfully requested.

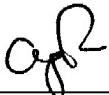
As discussed above, the cited references neither disclose nor suggest an etching solution comprising HF and a specific ether compound in specific proportions and the etching effects obtained by using such an etching solution. Therefore, the inventions as defined in the amended claims is both novel and unobvious.

Withdrawal of all rejections and allowance of claims 1-5, 12-18, 21 and 23 is earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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